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1980 N. Atlantic Ave., Suite 230
Coca Beach, FL 32931
(321) 783-9735, (321) 853-8202 (AMU)

Applied Meteorology Unit (AMU) Quarterly Report

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Executive Summary

This report summarizes the Applied Meteorology Unit (AMU) activities for the second quarter of Fiscal Year 2005 (January - March 2005). A detailed project schedule is included in the Appendix.

Task Objective Lightning Probability Forecast: Phase I

Goal Develop a set of statistical equations to forecast the probability of lightning occurrence for the day. This will aid forecasters in evaluating flight rules and determining the probability of launch commit criteria violations, as well as preparing forecasts for ground operations.

Milestones The graphical user interface (GUI) was tested to make sure that the equations were producing the correct output.

Discussion As the GUI was tested, graphs were created that showed the change in probability due to changes in one predictor while holding all other predictors at a constant value. These graphs show the users how sensitive the output probabilities are to changes in one predictor value versus changes in the others.

Task Severe Weather Forecast Decision Aid

Goal Create a new forecast aid to improve the severe weather watches and warnings for the protection of Kennedy Space Center (KSC)/Cape Canaveral Air Force Station (CCAFS) personnel and property.

Milestones The display used to evaluate the stability indices was changed from scatter plots to stacked column graphs, providing a different perspective on the relationships between the indices and severe weather. An interactive web-based severe weather forecast tool was developed and delivered to the 45th Weather Squadron (45 WS) for initial evaluation.

Discussion With the new graphs, some of the indices show stronger relationships to severe weather occurrence. Specific index thresholds and other criteria were incorporated into the severe weather forecast tool which is now ready for forecaster testing during the upcoming warm season.

Task Stable Low Cloud Evaluation

Goal Examine archived data collected during rapid stable cloud development events resulting in cloud ceilings below 8000 ft at the Shuttle Landing Facility (SLF). Document the atmospheric conditions favoring this type of cloud development to improve the ceiling forecast issued by the Spaceflight Meteorology Group (SMG) for Shuttle landings at KSC.

Milestones Identified days in the time period 1993 – 2003 that had low-level temperature inversions and cloud ceilings below 8000 ft. Retrieved visible satellite images from those same days for comparison.

Discussion Approximately 25 days of satellite images were retrieved from the satellite database and loaded onto the AMU weather display systems. These images were analyzed to identify days with rapid low cloud development.

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Executive Summary, *continued*

Task Hail Index

Goal Evaluate current techniques used by the 45 WS to forecast the probability of hail occurrence and size. Hail forecasts are required to protect personnel and material assets at KSC, CCAFS, Patrick Air Force Base and the Melbourne International Airport. The evaluation results will be used by the 45 WS to determine if a new technique is needed.

Milestones Used data from the Cloud-to-Ground Lightning Surveillance System (CGLSS) to evaluate the Neumann-Pfeffer Thunderstorm Index (NPTI) technique, as the hail size forecast generated by the computer code is contingent on a "yes" thunderstorm forecast by the NPTI.

Discussion On 966 days with lightning activity in the local area as indicated by CGLSS, the NPTI forecast a "yes" on only 511 days. This level of performance suggests that the computer code should be modified to generate a forecast hail size independent of the NPTI forecast.

Task RSA and Legacy Wind Sensor Evaluation

Goal Compare wind speed and direction statistics from the legacy and RSA sensors on the Eastern (ER) and Western (WR) Ranges to determine the impact of the sensor changes on wind measurements. The 45 WS and 30th Weather Squadron need to know of any differences in the measurements between the two systems as they use these winds to issue weather advisories for operations.

Milestones Analyzed 4 hours of RSA and legacy wind data from Tower 300 on the WR on a day with northeast winds at 10 to 20 kts.

Discussion The average wind speed and direction were similar for both instruments but the RSA peak speeds were several knots higher than the legacy peak speeds. A study using synthetic data showed that the algorithm used to calculate peak speeds for the legacy sensors was different than that for the RSA sensors, and likely caused a large percentage of the difference. Further tests are underway.

Task Volume Averaged Height Integrated Radar Reflectivity (VAHIRR)

Goal Transition the VAHIRR algorithm into operations. The current lightning launch commit criteria (LLCC) for anvil clouds to avoid triggered lightning are overly conservative and lead to costly launch delays and scrubs. The VAHIRR algorithm was developed as a result of the Airborne Field Mill program to evaluate a new LLCC for anvil clouds. This algorithm will assist forecasters in providing fewer missed launch opportunities with no loss of safety compared with the current LLCC.

Milestones The VAHIRR algorithm was acquired from the National Center for Atmospheric Research.

Discussion The VAHIRR algorithm was received and installed on a local computer for development. There were also several discussions with Mr. Tim Crum and Mr. Randy George of the Radar Operations Center in Norman, OK on the process of integrating new algorithms into the WSR-88D operational system.

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Executive Summary, *continued*

Task	Mesoscale Model Phenomenological Verification Evaluation
Goal	Find model weather-phenomena verification tools in the literature that could be transitioned into operations. Forecasters use models to aid in forecasting weather phenomena important to launch, landing, and daily ground operations. Methods that verify model performance are needed to help forecasters determine the model skill in predicting certain phenomena.
Milestones	Collected journal articles describing the development and/or use of new phenomenological verification techniques. Created tables containing information about each technique.
Discussion	The tables include the article reference, weather phenomenon being verified, model being verified, model and observational data used, name of the new technique, and the feasibility of transitioning the technique to operations.
Task	ARPS Optimization and Training Extension
Goal	Provide assistance and support for upgrading and improving the operational Advanced Regional Prediction System (ARPS) and ARPS Data Analysis System (ADAS) that is used to make operational forecasts at the National Weather Service in Melbourne, FL (NWS MLB) and SMG forecast offices.
Milestones	Completed the upgrade of the operational ADAS to software version 5.1.2 at the NWS MLB, and created a data-conversion program to process Automated Surface Observing System (ASOS) data.
Discussion	The upgrade and installation of ADAS onto the new Linux workstation at the NWS MLB was completed. A new data-ingest program was written to improve the ADAS analysis quality at off-hour times by incorporating ASOS observations. The AMU also corrected an erroneous specification of soil type over the Bahamas and improved the terrain resolution.
Task	User Control Interface for ADAS Data Ingest
Goal	Develop a GUI to help forecasters at NWS MLB and SMG manage the data sets assimilated into the operational ADAS.
Milestones	Completed installation of GUI at NWS MLB.
Discussion	A fully functional ADAS control GUI was installed at NWS MLB following trouble-shooting of certain map background issues.

Special Notice to Readers

Applied Meteorology Unit (AMU) Quarterly Reports are now available on the Wide World Web (WWW) at http://science.ksc.nasa.gov/amu/.

The AMU Quarterly Reports are also available in electronic format via email. If you would like to be added to the email distribution list, please contact Ms. Winifred Lambert (321-853-8130, lambert.winifred@ensco.com). If your mailing information changes or if you would like to be removed from the distribution list, please notify Ms. Lambert or Dr. Francis Merceret (321-867-0818, Francis.J.Merceret@nasa.gov).

Background

The AMU has been in operation since September 1991. Tasking is determined annually with reviews at least semi-annually. The progress being made in each task is discussed in this report with the primary AMU point of contact reflected on each task.

AMU ACCOMPLISHMENTS DURING THE PAST QUARTER

SHORT-TERM FORECAST IMPROVEMENT

Objective Lightning Probability (Ms. Lambert and Mr. Wheeler)

The 45th Weather Squadron (45 WS) forecasters include a probability of thunderstorm occurrence in their daily morning briefings. This information is used by personnel involved in determining the possibility of violating Launch Commit Criteria (LCC), evaluating Flight Rules, and planning for daily ground operation activities on Kennedy Space Center (KSC)/Cape Canaveral Air Force Station (CCAFS). Much of the current lightning probability forecast is based on a subjective analysis of model and observational data. The forecasters requested that a lightning probability forecast tool based on statistical analysis of historical warm-season data be developed. Such a tool would increase the objectivity of the daily thunderstorm probability forecast. The AMU is developing statistical lightning forecast equations that will provide a lightning occurrence probability for the day by 1100 UTC (0700 Eastern Daylight Time (EDT)) during the months May – September (warm season). The tool will be based on the results from several research projects. If tests of the equations show that they improve the daily lightning forecast, the AMU will develop a PC-based tool from which the daily probabilities can be displayed by the forecasters. The three data types to be used in this task were described in previous AMU Quarterly Reports (Q4 FY03 and Q1 FY04):

- Cloud-to-Ground Lightning Surveillance System (CGLSS) data,
- 1200 UTC sounding data from synoptic sites in Florida, and
- 1000 UTC CCAFS sounding (XMR) data.

Ms. Lambert is using the S-PLUS® software package (Insightful Corporation 2000) to process and analyze the data, and to develop the lightning forecast equations.

GUI Testing: Predictor Response Curves

A description of the graphical user interface (GUI) that calculates the daily lightning probability is provided in the previous AMU Quarterly Report (Q1 FY05). Following a procedure outlined by Mr. Roeder of the 45 WS, Ms. Lambert generated curve and bar charts for each month to determine the response of the calculated lightning probability to changes in predictor values while holding all other predictor values constant. This was done to test the GUI for calculation errors and to determine how changes in the individual predictor values affect the output probability. In order to use

a constant daily climatology value, the 15th of the month was used in each monthly test. As the individual stability indices were tested, the flow regime and persistence values were held constant at SW and Yes, respectively and the other values not being tested were held constant at their median value for the month. The value range of the index being varied covered the observed range in the month for the period of record.

May

The charts for May 15 are in Figure 1. The changes in probability due to changes in the predictors Thompson Index (TI) and temperature at 500 mb (T_{500}), or response curves, are in Figure 1a. As TI was varied from -20 – 50, T_{500} was held constant at its May median value of -10 °C. Conversely, as T_{500} was varied from -20 – 0 °C, TI was held at its May median value of 17. The curves are non-linear and shaped similarly to a logistic regression curve. The probabilities were more sensitive to changes in T_{500} than in TI.

The bar chart in Figure 1b shows the alternate case of varying flow regime and persistence with TI and T_{500} held constant at their May median values. The SE-1 flow regime produced the highest probability and the probabilities were higher for every flow regime when Persistence = Yes. The probability values are quite low for all flow regimes and both persistence categories, ranging from 4% (NE, No) to 41% (SE-1, Yes). This is likely an artifact of the lightning climatology for May. Of the 420 available days in May, lightning occurred on only 97, yielding ~23% for the monthly climatology of lightning occurrence. The median value for TI is below 20, which is the threshold above which thunderstorm formation becomes probable. Even when TI = 20 in Figure 1a, the probability is 37%. The median value for T_{500} is conducive to thunderstorm formation, but this predictor contributed least to the explanation of variance in the predictand and has a relatively small effect on the probability outcome. In Figure 1a, T_{500} = -10 °C yields ~30% probability of lightning occurrence. It follows that for days that exhibit values typical of May climatology, the calculated probabilities will tend to be low.

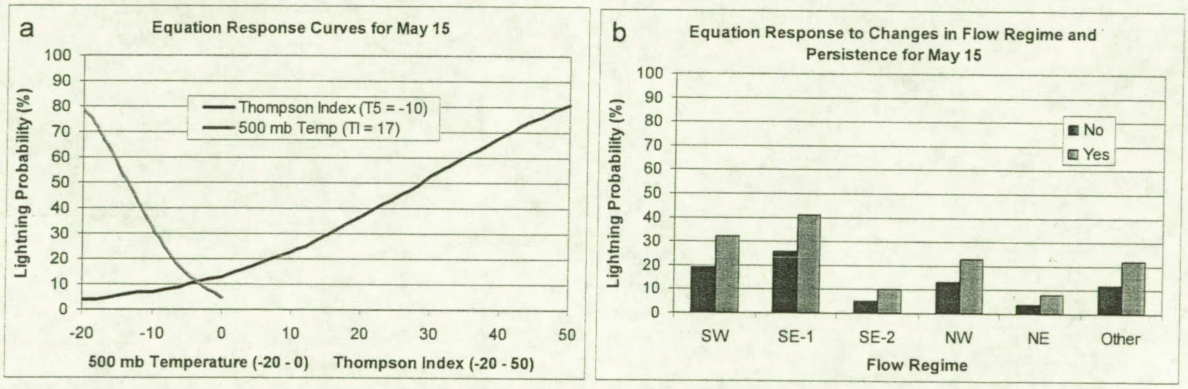


Figure 1. Equation response charts for May 15: (a) change in probability due to changes in TI and T_{500} with flow regime = SW, persistence = Yes, TI = 17 when T_{500} was varied from -20 – 0 °C (purple curve), and T_{500} = -10 °C when TI was varied from -20 – 50 (blue curve); (b) changes in probability due to changes in flow regime and persistence with TI = 17 and T_{500} = -10 °C. The red bars are for persistence = Yes and the blue bars for persistence = No.

June

The charts for June 15 are in Figure 2. The probability response curves due to changes in the predictors Lifted Index (LI) and 800-600 mb average relative humidity (RH) are in Figure 2a. As LI was varied from -10 – 10, RH was held constant at its June median value of 62%. Conversely, as RH was varied from 0 – 100%, LI was held at its June median value of -2. The probabilities appear more sensitive to changes in LI than RH. The curves are non-linear, but do not approach 0% probability asymptotically as do the curves for May. Due to the nature of logistic regression, the asymptote would occur closer to 0 on the y-axis. The lowest probability values are slightly greater than 20% for both predictors causing the curves to be truncated before reaching probabilities closer to 0.

The bar chart in Figure 2b shows the alternate case of varying flow regime and persistence with LI and RH held constant at their median values. The SW flow regime produced the highest probabilities. The other flow regimes were similar to each other except for NE, which had the lowest probabilities for both persistence categories. The probabilities were noticeably higher for every flow regime when Persistence = Yes. Persistence ranked second in its explanation of predictand variance and, as such, would have a large effect on the calculated probability. The probability values are much higher overall than the corresponding values for May. Unlike May, the monthly climatology for June was 57%. Both median values for LI and RH are at least minimally conducive for thunderstorm formation. The flow regime ranked fourth in the equation, which would indicate a minimal effect on the calculated probability. However, the predictor value for the NE flow regime is sufficiently small as to significantly decrease the probability of lightning occurrence when present.

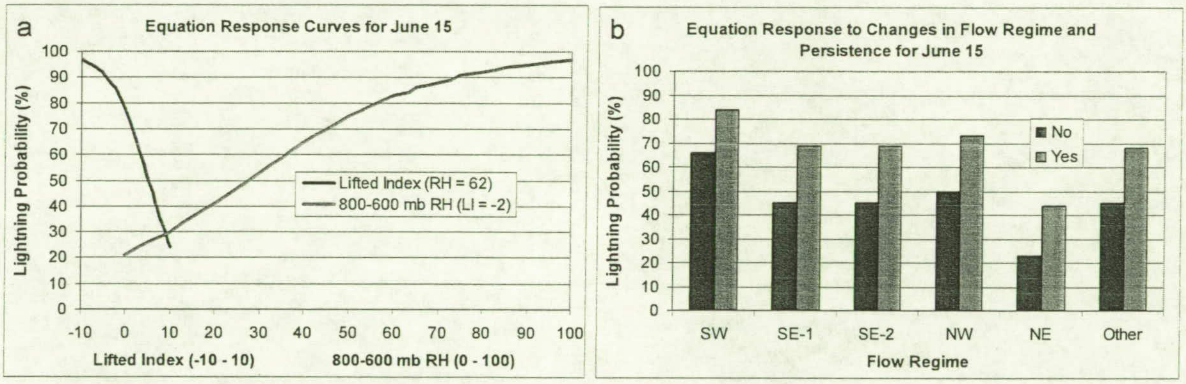
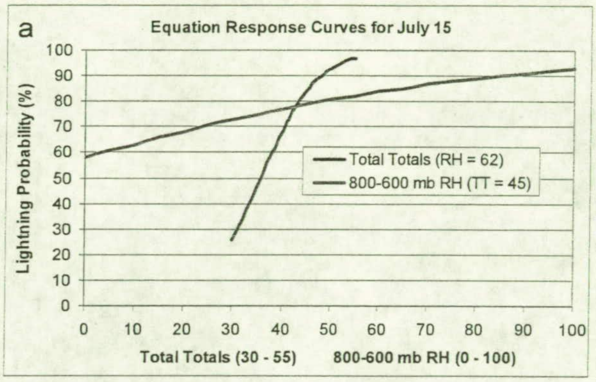


Figure 2. Equation response charts for June 15: (a) change in probability due to changes in LI and RH with flow regime = SW, persistence = Yes, LI = -2 when RH was varied from 0 – 100%, and RH = 62% when LI was varied from -10 – 10; (b) changes in probability due to changes in flow regime and persistence with LI = -2 and RH = 62%. The red bars are for persistence = Yes and the blue bars for persistence = No.

July

The charts for July 15 are in Figure 3. The probability response curves due to changes in the predictors Total Totals (TT) and RH are in Figure 3a. As TT was varied from 30 – 55, RH was held constant at its July median value of 62%. Conversely, as RH was varied from 0 – 100%, TT was held at its July median value of 45. The probabilities are more sensitive to changes in TT than RH. The TT curve exhibits the same truncation issue as seen in Figure 2a for June, but the RH curve approaches 1 slowly beginning at the lowest probability of 58% for 0% humidity. The values along the RH curve also seem to indicate that changes in RH would have a small effect on the calculated probability. It ranked third among the predictors for July whereas TT ranked first in its reduction of the residual deviance.

The bar chart in Figure 3b shows the alternate case of varying flow regime and persistence with TT and RH held constant at their July median values. The SW flow regime produced the highest probabilities, and the probabilities were higher for every flow regime when Persistence = Yes. Overall, the probability values are quite high for each flow regime ranging from 49% (NE, No) to 84% (SW, Yes). The flow regime ranked last in the equation and would have the smallest effect on the calculated probability. The climatological median values for TT and RH are at least minimally conducive to thunderstorm formation. The daily climatology value for July 15 is 66%. Although the daily climatology ranked fourth just ahead of flow regime in its reduction of residual deviance, it still shows that July was an active lightning month and calculated probability values will tend to be high.



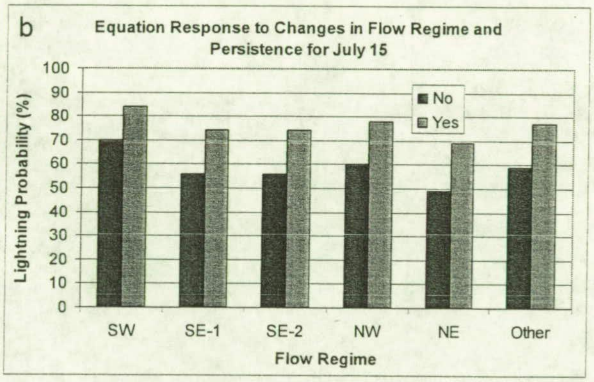


Figure 3. Equation response charts for July 15: (a) change in probability due to changes in TT and RH with flow regime = SW, persistence = Yes, TT = 45 when RH was varied from 0 – 100% (purple curve), and RH = 62% when TT was varied from 30 – 50 (blue curve); (b) changes in probability due to changes in flow regime and persistence with TT = 45 and RH = 62%. The red bars are for persistence = Yes and the blue bars for persistence = No.

August

The charts for August 15 are in Figure 4. The probability response curves due to changes in the predictors TT, K-Index (KI), and RH are in Figure 4a. As TT was varied from 25 – 55, KI and RH were held constant at their August median values of 31 and 60%, respectively. As KI was varied from -10 – 50, TT and RH were held at their August median values of 44 and 60%, respectively. Finally, as RH was varied from 0 – 100%, TT and KI were held at their August median values of 44 and 31, respectively. The probabilities appear least sensitive to changes in RH and most sensitive to changes in TT. The TT and KI curves exhibit the same truncation issue described earlier. The values along the RH curve seem to indicate that changes in RH would have a small effect on the calculated probability. It ranked fifth among the six predictors for August whereas KI ranked first.

The bar chart in Figure 4b shows the alternate case of varying flow regime and persistence with TT, KI, and RH held constant at their August median values. The SW and NW flow regimes produced the highest probabilities with SW having the largest values. The probabilities were higher for every flow regime when Persistence = Yes, but only by a small amount. Persistence ranked last in the equation for August lightning occurrence, and therefore would have only a small effect on the calculated probability. The NE flow regime produced the lowest probabilities by far. Overall, the probability values exhibit a large range from 25% (NE, No) to 87% (SW, Yes). The climatological median values for TT, KI, and RH are all at least minimally conducive to lightning occurrence except during the NE flow regime. The flow regime lightning probability for NE flow in August is 23%. Since flow regime ranked second in the equation, this value would have a large effect on the calculated probability.

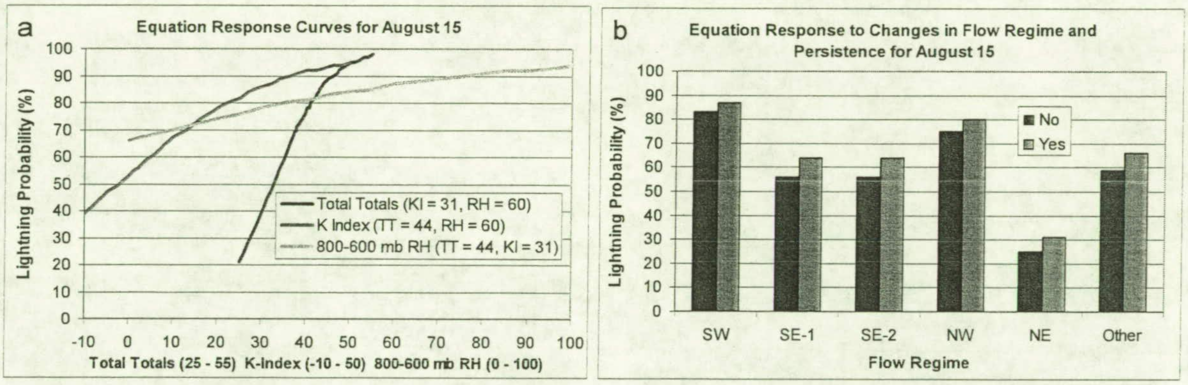


Figure 4. Equation response charts for August 15: (a) change in probability due to changes in TT, KI, and RH with flow regime = SW, persistence = Yes, TT = 44 and KI = 31 when RH was varied from 0 – 100% (green curve), TT = 44 and RH = 60% when KI was varied from -10 – 50 (purple curve), and KI = 31 and RH = 60% when TT was varied from 25 – 55 (blue curve); (b) changes in probability due to changes in flow regime and persistence with TT = 44, KI = 31, and RH = 60%. The red bars are for persistence = Yes and the blue bars for persistence = No.

September

The charts for September 15 are in Figure 5. The probability response curves due to changes in the predictors LI and RH are in Figure 5a. As LI was varied from -10 – 10, RH was held constant at its September median value of 62%. As RH was varied from 0 – 100%, LI was held at its September median value of -2. The probabilities are least sensitive to changes in RH and most sensitive to changes in LI. The curves exhibit the same truncation issue and have similar values to those in June.

The bar chart in Figure 5b shows the alternate case of varying flow regime and persistence with LI and RH held constant at their September median values. The SW flow regime produced the highest probability and SE-1 the second highest. The probabilities were higher for every flow regime when Persistence = Yes. The percent increase in probability from No to Yes Persistence is large for each flow regime: over 100% for SE-2, NW, NE, and Other, 50% for SW, and 70% for SE-1. Persistence ranked first among all predictors in the equation and has the largest effect on the calculated probability. The NW flow regime produced the lowest probabilities, but there were only a small number of days with this flow regime in September and lightning did not occur on any of the days. There is also a large difference in probability between the flow regimes ranging from 3% (NW, No) to 75% (SW, Yes). The flow regime probability ranked second in the equation. As with persistence, it follows that flow regime would also have a large influence on the calculated probability. While the climatological median values of the stability parameters are at least minimally conducive to lightning occurrence, the probability values in Figure 5 are highly dependent on the choice for persistence and flow regime.

For more information on this work, contact Ms. Lambert at lambert.winifred@ensco.com or 321-853-8130.

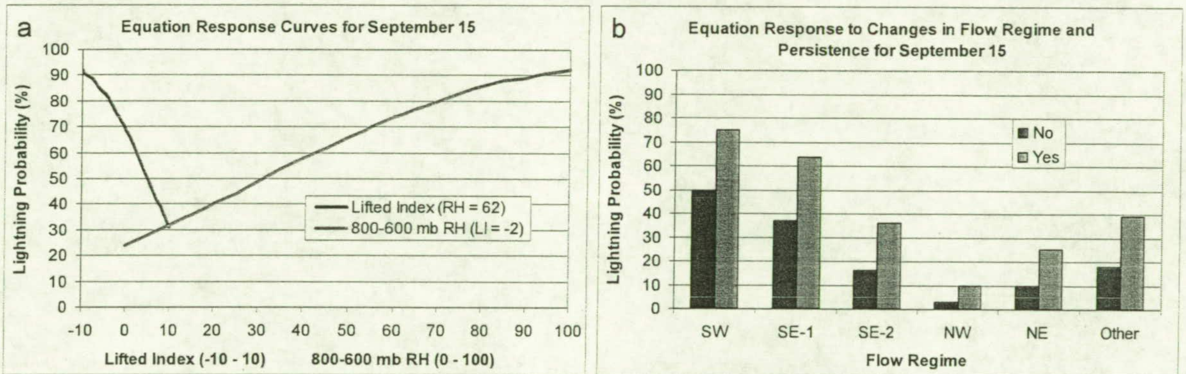


Figure 5. Equation response charts for September 15: (a) change in probability due to changes in LI and RH with flow regime = SW, persistence = Yes, LI = -2 when RH was varied from 0 – 100% (purple curve), and RH = 62% when LI was varied from -10 – 10 (blue curve); (b) changes in probability due to changes in flow regime and persistence with LI = -2 and RH = 62%. The red bars are for persistence = Yes and the blue bars for persistence = No.

Severe Weather Forecast Decision Aid (Mr. Wheeler and Dr. Bauman)

The 45 WS Commander's morning weather briefing includes an assessment of the likelihood of local convective severe weather for the day in order to enhance protection of personnel and material assets of the 45th Space Wing, CCAFS, and KSC. The severe weather elements produced by thunderstorms include tornadoes, wind gusts ≥ 50 kts, and/or hail with a diameter ≥ 0.75 in. Forecasting the occurrence and timing of these phenomena is challenging for 45 WS operational personnel. The AMU has been tasked with the creation of a new severe weather forecast decision aid, such as a flow chart or nomogram, to improve the various 45 WS severe weather watches and warnings. The tool will provide severe weather guidance for the day by 1100 UTC (0700 EDT).

Dr. Bauman analyzed relationships between each stability parameter from the 1000 UTC XMR sounding and calculated threshold criteria for the severe weather threat for each day-type (severe, lightning, and non-lightning).

The threshold criteria were provided by the

- 45 WS Severe Weather Worksheet,
- NWS Jacksonville, FL Severe Weather Checklist,
- Forecaster experience, or
- National criteria if local criteria were not available.

The intent was to evaluate each threshold level to determine if they could be used as predictors of severe weather. If so, the next step was to determine if the threshold values should be adjusted for the local KSC/CCAFS area. Statistics and stacked column graphs were developed based on these calculations to show the relationship of each stability index to the day-type.

Of the 14 stability parameters examined, only 6 showed the potential as guidance to forecasters when considering severe weather in their morning forecast. Those six parameters include

- KI,
- TT,
- LI,
- TI,
- Precipitable Water (PW), and
- Cross Totals (CT).

The other eight parameters unable to discriminate between severe and non-severe days were the

- Severe Weather Threat (SWEAT),
- Showalter Stability Index,
- Convective Available Potential Energy (CAPE),
- CAPE based on the layer with maximum equivalent potential temperature,
- CAPE based on the forecast maximum surface temperature,
- Convective Inhibition,
- 500 mb Temperature, and
- 500 mb Dew Point Temperature.

The six stability parameters able to provide guidance have the following key discriminators:

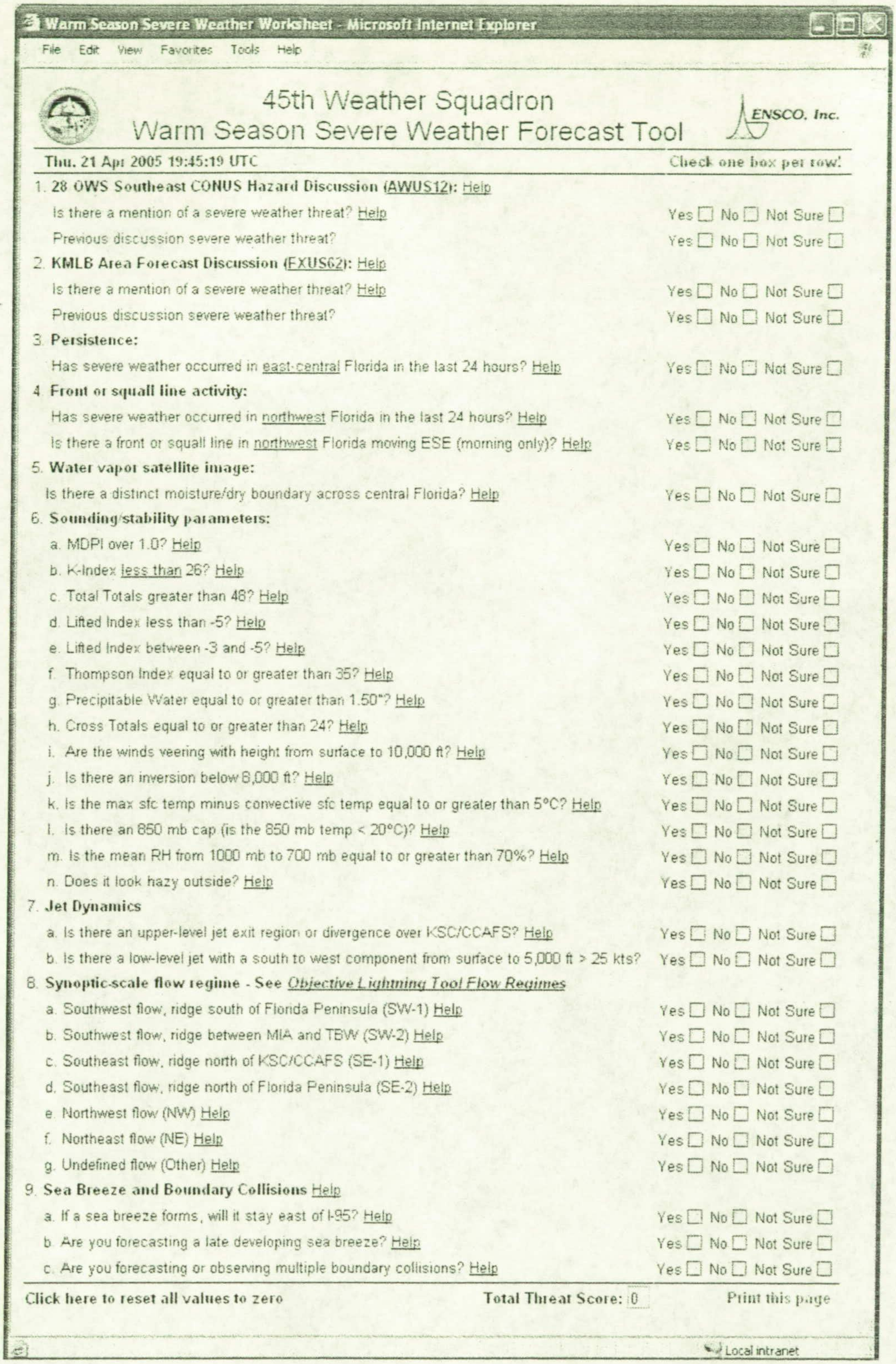
- When KI < 26, 39% of all days were non-lightning and only 8% had severe weather. The KI does not identify severe weather potential, but does indicate that severe weather is unlikely.
- When TT > 48, there was a 29% chance of severe weather. This was a rare occurrence but a significant discriminator.
- When LI < -5, there is a 25% chance of severe weather. When LI is between -5 and -3, there is a 16% chance of severe weather.
- When TI > 40, there is an 89% chance of severe weather. However, this occurs only 1% of the time during the warm season. When TI is between 35 and 39, there is a 20% chance of severe weather.
- When PW ≥ 1.50 inches there is a 15% chance of severe weather.
- When CT > 24, there is a 27% chance of severe weather. Similar to TT, CT > 24 occurs rarely (6% of warm season days) but it is a discriminator.

These six stability parameters combined with the synoptic scale flow regime, the position of jet streak dynamics, and other parameters were incorporated into an updated 45 WS Severe Weather Checklist.

Dr. Bauman and Mr. Wheeler incorporated the checklist into an interactive web-based Severe Weather Forecast Tool shown in Figure 6. The interactive tool uses a top-down approach. The first two questions require the forecaster to look beyond the local scale. The forecasts generated by the 28th Operational Weather Squadron at Shaw Air Force Base, SC and at the National Weather Service in Melbourne, FL (NWS MLB) are focused on a much larger area than the 45 WS forecasters, which provide a good first guess. The rest of the questions in the tool require the forecasters to think about the local causes of severe weather during the warm season regarding persistence, squall line activity, moisture boundaries, stability parameters, jet dynamics, synoptic flow regime, and sea breeze and boundary collisions. The tool is designed to allow the forecasters to answer Yes/No/Not Sure to the questions. Once all the questions have been answered, a threat score for the day is displayed. The higher the threat score the greater the likelihood of severe weather.

Mr. Wheeler worked with 45 WS personnel to set initial values for each criterion in the tool. During the 2005 warm season, the tool will be tested to refine the initial values and to determine a realistic threat score for determining the likelihood of severe weather.

Contact Mr. Wheeler at 321-853-8205 or wheeler.mark@ensco.com, or Dr. Bauman at 321-853-8202 or bauman.bill@ensco.com for more information on this work.



Warm Season Severe Weather Worksheet - Microsoft Internet Explorer

File Edit View Favorites Tools Help

45th Weather Squadron
Warm Season Severe Weather Forecast Tool

ENSCO, Inc.

Thu. 21 Apr 2005 19:45:19 UTC — Check one box per row!

1. 28 OWS Southeast CONUS Hazard Discussion (AWUS12): Help
   - Is there a mention of a severe weather threat? Help — Yes ☐ No ☐ Not Sure ☐
   - Previous discussion severe weather threat? — Yes ☐ No ☐ Not Sure ☐
2. KMLB Area Forecast Discussion (FXUS62): Help
   - Is there a mention of a severe weather threat? Help — Yes ☐ No ☐ Not Sure ☐
   - Previous discussion severe weather threat? — Yes ☐ No ☐ Not Sure ☐
3. Persistence:
   - Has severe weather occurred in east-central Florida in the last 24 hours? Help — Yes ☐ No ☐ Not Sure ☐
4. Front or squall line activity:
   - Has severe weather occurred in northwest Florida in the last 24 hours? Help — Yes ☐ No ☐ Not Sure ☐
   - Is there a front or squall line in northwest Florida moving ESE (morning only)? Help — Yes ☐ No ☐ Not Sure ☐
5. Water vapor satellite image:
   - Is there a distinct moisture/dry boundary across central Florida? Help — Yes ☐ No ☐ Not Sure ☐
6. Sounding/stability parameters:
   - a. MDPI over 1.0? Help — Yes ☐ No ☐ Not Sure ☐
   - b. K-Index less than 26? Help — Yes ☐ No ☐ Not Sure ☐
   - c. Total Totals greater than 48? Help — Yes ☐ No ☐ Not Sure ☐
   - d. Lifted Index less than -5? Help — Yes ☐ No ☐ Not Sure ☐
   - e. Lifted Index between -3 and -5? Help — Yes ☐ No ☐ Not Sure ☐
   - f. Thompson Index equal to or greater than 35? Help — Yes ☐ No ☐ Not Sure ☐
   - g. Precipitable Water equal to or greater than 1.50"? Help — Yes ☐ No ☐ Not Sure ☐
   - h. Cross Totals equal to or greater than 24? Help — Yes ☐ No ☐ Not Sure ☐
   - i. Are the winds veering with height from surface to 10,000 ft? Help — Yes ☐ No ☐ Not Sure ☐
   - j. Is there an inversion below 8,000 ft? Help — Yes ☐ No ☐ Not Sure ☐
   - k. Is the max sfc temp minus convective sfc temp equal to or greater than 5°C? Help — Yes ☐ No ☐ Not Sure ☐
   - l. Is there an 850 mb cap (is the 850 mb temp < 20°C)? Help — Yes ☐ No ☐ Not Sure ☐
   - m. Is the mean RH from 1000 mb to 700 mb equal to or greater than 70%? Help — Yes ☐ No ☐ Not Sure ☐
   - n. Does it look hazy outside? Help — Yes ☐ No ☐ Not Sure ☐
7. Jet Dynamics
   - a. Is there an upper-level jet exit region or divergence over KSC/CCAFS? Help — Yes ☐ No ☐ Not Sure ☐
   - b. Is there a low-level jet with a south to west component from surface to 5,000 ft > 25 kts? — Yes ☐ No ☐ Not Sure ☐
8. Synoptic-scale flow regime - See *Objective Lightning Tool Flow Regimes*
   - a. Southwest flow, ridge south of Florida Peninsula (SW-1) Help — Yes ☐ No ☐ Not Sure ☐
   - b. Southwest flow, ridge between MIA and TBW (SW-2) Help — Yes ☐ No ☐ Not Sure ☐
   - c. Southeast flow, ridge north of KSC/CCAFS (SE-1) Help — Yes ☐ No ☐ Not Sure ☐
   - d. Southeast flow, ridge north of Florida Peninsula (SE-2) Help — Yes ☐ No ☐ Not Sure ☐
   - e. Northwest flow (NW) Help — Yes ☐ No ☐ Not Sure ☐
   - f. Northeast flow (NE) Help — Yes ☐ No ☐ Not Sure ☐
   - g. Undefined flow (Other) Help — Yes ☐ No ☐ Not Sure ☐
9. Sea Breeze and Boundary Collisions Help
   - a. If a sea breeze forms, will it stay east of I-95? Help — Yes ☐ No ☐ Not Sure ☐
   - b. Are you forecasting a late developing sea breeze? Help — Yes ☐ No ☐ Not Sure ☐
   - c. Are you forecasting or observing multiple boundary collisions? Help — Yes ☐ No ☐ Not Sure ☐

Click here to reset all values to zero — Total Threat Score: 0 — Print this page

Local intranet

Figure 6. The interactive web-based Severe Weather Forecast Tool. Users check only one box next to each question. The Total Threat Score is displayed at the end of the questions.

Stable Low Cloud Evaluation (Mr. Wheeler and Mr. Case)

Forecasters at the Space Meteorology Group (SMG) issue 30 to 90 minute forecasts for low cloud ceilings at the Shuttle Landing Facility (SLF) for all Space Shuttle missions. Mission verification statistics have shown cloud ceilings to be the biggest forecast challenge. Forecasters at SMG are especially concerned with rapidly developing clouds/ceilings below 8000 ft in a stable, capped thermodynamic environment, since these events are the most challenging to predict accurately. The AMU is tasked to develop a database of these cases, identify the onset, location, and if possible, dissipation times, and document the atmospheric regimes favoring this type of cloud development.

The forecasters at SMG indicated that these events typically take place in the cool season during daylight hours. Therefore, Mr. Case and Mr. Wheeler collected the morning XMR soundings and hourly surface observations at the SLF between 1100-2300 UTC during the cool season months of November-March 1993 - 2003, for a total of 10 cool seasons. Mr. Case completed the acquisition of all Florida observation and sounding data, and also completed the database of potential rapid stable cloud development days over the 10-year period of record.

Mr. Case and Mr. Wheeler began analyzing the database, removing days with low cloud ceilings at the SLF that did not have a thermally capped environment below 8000 ft. Each selected case day was then matched with archived satellite data to determine which days did not have satellite images. The missing satellite images will be requested from the Space Science Engineering Center at the University of Wisconsin.

Approximately 25 case days were available in the existing AMU archive. The visible satellite images from this archive were loaded on the Meteorological Interactive Data Display System for analysis. These images were then analyzed visually in 15 to 30 minute increments to determine if there was a rapidly developing low cloud event for each day.

Contact Mr. Wheeler at 321-853-8205 or wheeler.mark@ensco.com, or Mr. Case at 321-853-8264 or case.jonathan@ensco.com for more information on this work.

Hail Index (Dr. Short and Mr. Wheeler)

The 45 WS has an operational requirement to issue weather advisories for hail of any size, including severe hail with a diameter ≥ 0.75 in. These advisories are issued for KSC, CCAFS, Patrick Air Force Base, and the Melbourne International Airport to protect personnel and material assets. The forecasters must also provide the probability of hail at any of these locations for the day at the 0700L weather briefing. The 45 WS tasked the AMU to evaluate the current operational tools used to make daily hail forecasts and, if needed, to develop a new tool tuned to the local area.

The Thunderstorm Probability Study (TPS) bulletin, based on the work of Neumann (1971), includes the Neumann-Pfeffer Thunderstorm Index (NPTI) and is generated daily at the CCAFS balloon facility during the warm season months of May – September. The computer code that generates the bulletin uses information on the atmospheric stability, low-level moisture and winds from the XMR radiosonde observation. If the thunderstorm probability is indicated as "yes" then a forecast hail size is also generated and listed in the bulletin. The operational code does not generate a hail size forecast if the thunderstorm probability is "no." Because of the direct linkage between the NPTI forecast and the hail forecast, an evaluation of the former was made as part of this hail index task.

Validation of Thunderstorm Probability

Data from CGLSS were used to determine the skill of the NPTI in forecasting thunderstorm occurrence. Ms. Lambert generated a database of daily CGLSS lightning strike information over the KSC/CCAFS area as part of the lightning probability forecast study and that data was used in the present study to validate the NPTI.

Thunderstorm days ("yes") were defined as those with CGLSS strikes between 0700 EDT and midnight within the domain depicted in Figure 7. The circles show 45 WS lightning 5 n mi warning areas over KSC/CCAFS.

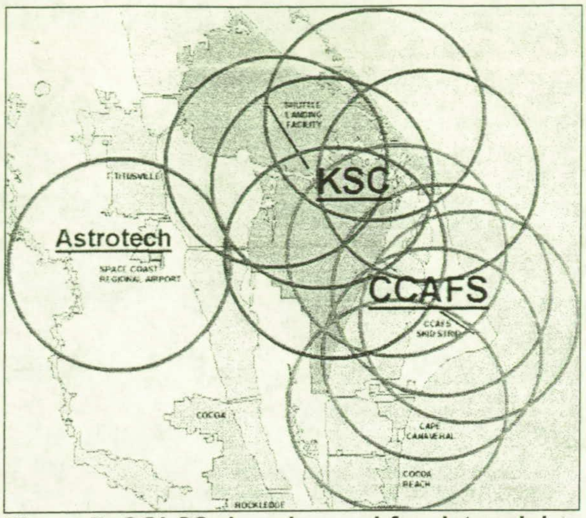


Figure 7. CGLSS domain used for determining thunderstorm days in the evaluation of the NPTI output.

The accuracy and skill of the NPTI forecasts were determined through a standard categorical analysis (Wilks 1995). This method is well suited for validation of forecasts with binary outcomes such as "yes" or "no". In the categorical analysis presented here the NPTI results are the "forecast" events and the CGLSS observations are the "observed" events. For the 14-year period from 1989 – 2002 a total of 1868 morning soundings were available during the warm season months, 87% of the total possible. Table 1 shows that lightning was observed on 927 days and forecast on 688 days.

Table 1 also shows the false alarm rate (FAR) was 25.7%, indicating that when the NPTI forecast was "yes" there was a non-negligible probability that thunderstorm activity would not occur. The probability of detection of "yes" (PODy) was modest at 55.1% with only slightly more than half of the thunderstorm days correctly forecast by the NPTI technique. As a consequence, the other measures of forecast skill, the Critical Success Index (CSI), True Skill Statistic (TSS), and Heidke Skill Score (HSS) are also relatively low at < 0.50.

Table 1. Contingency table for thunderstorm occurrence based on the CGLSS-observed lightning data versus the NPTI forecast of thunderstorm activity.

		CGLSS Lightning			FAR = 25.7 %
		Yes	No	**Totals**	PODy = 55.1%
NPTI Forecast	Yes	**511**	**177**	688	CSI = 0.463
	No	**416**	**764**	1180	TSS = 0.363
	Totals	927	941	1868	HSS = 0.364

Given the relative poor performance of the NPTI in forecasting thunderstorm activity, and its direct linkage to the hail forecast, the AMU may recommend modification of the operational code to list forecast hail sizes in the TPS bulletin independent of the NPTI forecast of thunderstorm probability.

Contact Dr. Short at 321-853-8105 or short.david@ensco.com, or Mr. Wheeler at 321-853-8205 or wheeler.mark@ensco.com for more information on this work.

INSTRUMENTATION AND MEASUREMENT

I&M and RSA Support (Mr. Wheeler)

With help from Lockheed Martin personnel, Mr. Wheeler was able to install and configure a separate AMU Advanced Weather Interactive Processing System (AWIPS) workstation that can be used for data archive and retrievals of local weather data. This will be useful for current and future AMU tasks.

RSA and Legacy Wind Sensor Evaluation (Dr. Short and Mr. Wheeler)

Launch Weather Officers, forecasters, and Range Safety analysts need to understand the performance of wind sensors at the Eastern (ER) and Western (WR) Ranges for weather warnings, watches, and advisories, special ground processing operations, launch pad exposure forecasts, user LCC forecasts and evaluations, and toxic dispersion support. Through the Range Standardization and Automation (RSA) program, the current weather tower wind instruments are being switched from the legacy cup-and-vane sensors to sonic sensors. The legacy sensors measure wind speed and direction mechanically, but the sonic RSA sensors have no moving parts. These differences in wind measuring techniques could cause differences in the statistics of peak wind speed and wind direction variability. The 45 WS and the 30 WS requested that the AMU compare the data between RSA and legacy sensors to determine if there are significant differences between the systems.

Dr. Short and Mr. Wheeler obtained one month of 1-minute legacy and RSA wind speed and direction data from five towers on the WR: 301, 300, 102, 60 and 54. They performed a preliminary comparison of the legacy and RSA data obtained from Tower 300 on 17 January 2005, and examined the potential consequences of differences in RSA and legacy algorithms for computing peak wind speeds. Figure 8 shows a schematic representation of a horizontal cross-section through Tower 300. At each of five wind sensor levels (12, 54, 102, 204, and 300 ft), there are two RSA instrument booms and one legacy instrument boom. The RSA booms are labeled NW and SE in Figure 8.

The RSA and legacy wind sensors provide wind speed and direction data every second. The algorithms for computing the average wind speeds and directions from the two sensors are the same. However, algorithms for computing peak speeds are different. For the RSA instruments the raw sensor data is updated every second and a peak wind speed is reported every minute. For the legacy instrument the raw sensor data is processed with the GU10(MAX) and GU40(MAX) algorithms, denoting 10-second and 40-second data windows, respectively. More details on the GU10(MAX) and GU40(MAX) algorithms will be given later.

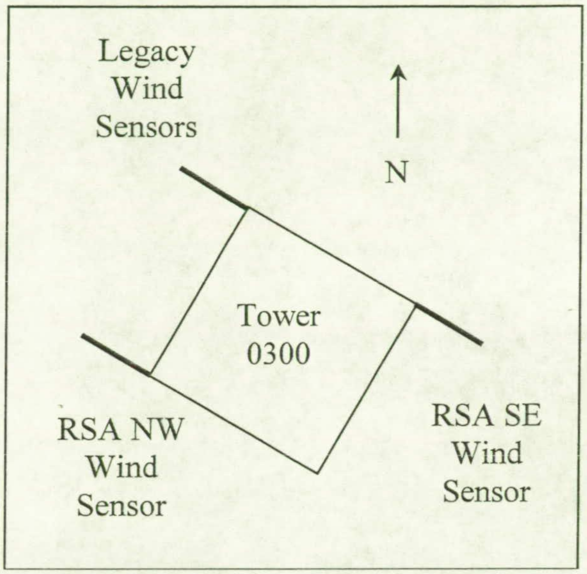


Figure 8. Schematic of the horizontal cross-sectional view of Tower 300. The legacy and RSA wind sensors are located at 5 levels: 12, 54, 102, 204, and 300 ft.

On the afternoon of 17 January 2005 the average winds were from the NE at 13 kts, giving the RSA SE and legacy wind sensors similar exposure, unobstructed by the tower. Figure 9 shows a scatter diagram of 1-minute average wind speeds for the legacy and RSA SE sensors at 300 ft for the time period 1600 – 2000 UTC. The legacy wind speeds were reported to the nearest whole knot, whereas the RSA wind speeds were reported to the nearest 0.1 ms^{-1} and converted to knots. The overall average wind speeds from the two sensors were within 0.5 kt (legacy 12.45 kts versus RSA 12.92 kts) and highly correlated. Figure 10 shows a scatter diagram of 1-minute average wind directions from the same sensors and time period as Figure 9. The overall average wind directions were within 2 degrees (legacy 35.9 versus RSA 37.8) and highly correlated.

Figures 11 and 12 show scatter diagrams of peak winds from the legacy and RSA SE sensors at 300 ft for the time period 1600 – 2000 UTC. The peak winds in Figure 11 were calculated with the GU10(MAX) algorithm, and those in Figure 12 with the GU40(MAX) algorithm. The RSA overall average peak speeds in Figure 11 were 2.82 kts higher than the legacy peak speeds (legacy 13.13 kts versus RSA 15.92 kts) and highly correlated. In Figure 12, the RSA overall average peak speeds were 4.55 kts higher than the legacy peak speeds (legacy 11.37 kts versus RSA 15.92 kts) and highly correlated. Also note that the average of GU40(MAX), 11.37 kts, is less than the overall average legacy wind speed, 12.45 kts. This was an unexpected result.

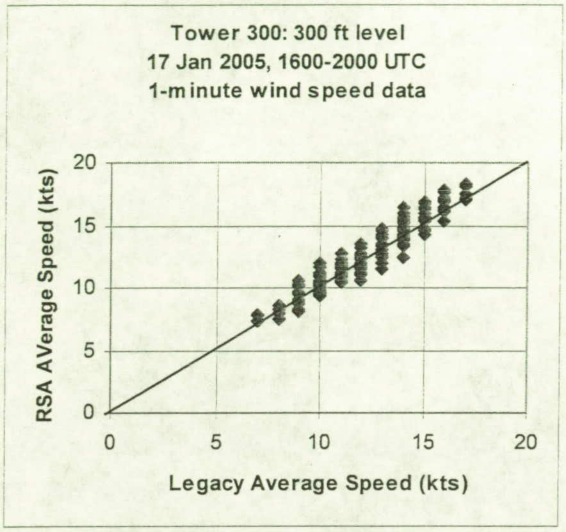


Figure 9. The legacy versus RSA SE 1-minute average wind speed data from the 300 ft level of WR Tower 300 for the 4-hour interval 1600 – 2000 UTC on 17 January 2005.

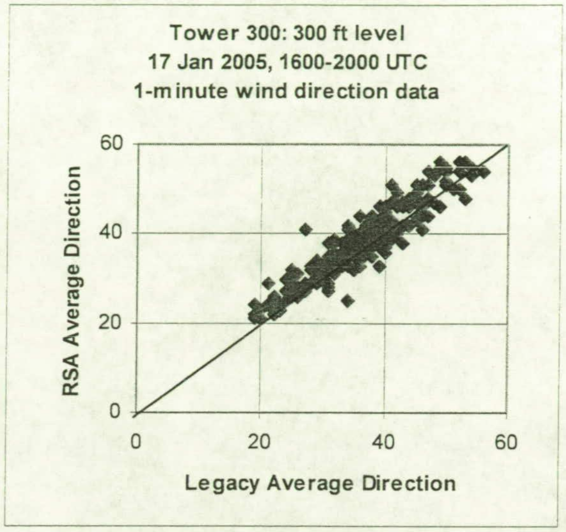


Figure 10. The legacy versus RSA SE 1-minute wind direction data from the 300 ft level of WR Tower 300 for the 4-hour interval 1600 – 2000 UTC on 17 January 2005.

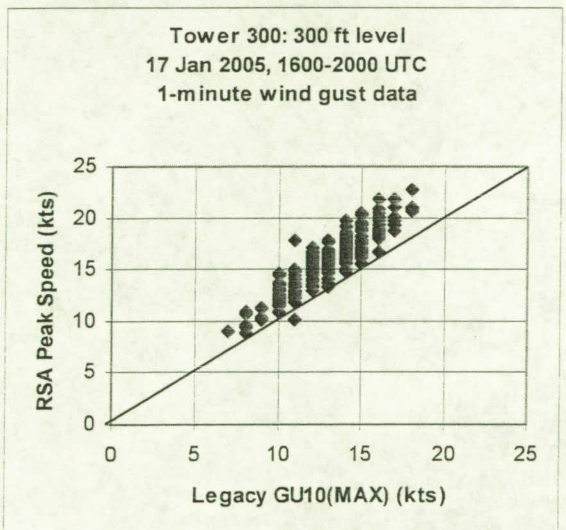


Figure 11. The legacy versus RSA SE 1-minute peak wind speed data from the 300 ft level of WR Tower 300 for the 4-hour interval 1600 – 2000 UTC on 17 January 2005. The legacy peak wind data is labeled GU10(MAX).

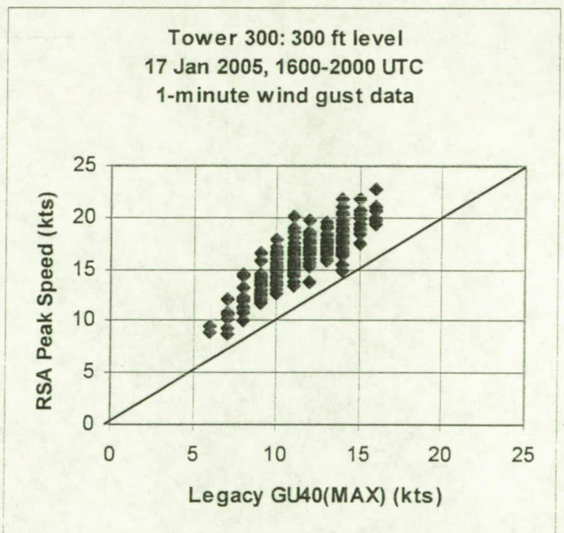


Figure 12. The legacy versus RSA SE 1-minute peak wind speed data from the 300 ft level of WR Tower 300 for the 4-hour interval 1600 – 2000 UTC on 17 January 2005. The legacy peak wind data is labeled GU40(MAX).

The results shown in Figures 9 - 12 for 300 ft were also representative of the wind sensors at lower levels on the tower (204, 102, 54, and 12 ft). The conclusion from this preliminary comparison is that the average wind speeds and directions from the RSA and legacy sensors show good agreement. However, the peak wind speeds computed from the RSA 1-second data stream are systematically higher than those computed from the legacy 1-second data stream.

In an effort to understand the discrepancy between RSA and legacy peak wind speeds, Dr. Short requested a description of the legacy GU10(MAX) and GU40(MAX) algorithms. The following is an excerpt from the bottom of Page 12 of Wind Sensor Document 0407004SRSSN00-A, provided by the 30 WS:

"The 10-second gusts shall be calculated as follows:

Given the 120 1-second samples available every 2 minutes, the data is broken down into 10-second "windows" for the previous 2 minutes. Each 10-second window (1-10, 2-11, 3-12, … 51-60, 52-61, …, 110-119, 111-120) shall be checked for the minimum speed. The 10-second gust is the highest value found each minute after scanning the 10-second windows for the previous 2 minutes."

The phrase "*shall be checked for the minimum speed*" in the above paragraph suggests that the GU10(MAX) algorithm first finds minima within 10-second data windows, and then finds the maximum of those minima over a 2-minute interval. Similar verbiage is used to describe GU40(MAX) using 40-second windows.

In order to determine if the observed differences between the legacy and RSA peak winds could be accounted for by the GU10(MAX) and GU40(MAX) algorithms, Dr. Short used a synthetic database of 1-second wind speeds since the true 1-second data from the sensors were not available. The synthetic database was generated by a first-order autoregressive model with parameters chosen to realistically simulate wind speed variability with an average wind speed of 12.75 kts. The synthetic data was processed in two different ways. One to simulate the peak speeds determined from a standard peak speed algorithm and another to simulate the legacy GU10(MAX) and GU10(MAX) peak speed algorithms.

Table 2 shows a comparison of legacy and RSA SE wind speed statistics with similar statistics from the synthetic data. Note that the simulated GU10(MAX) and GU40(MAX) are both less than the simulated peak, as observed in the comparison of legacy and RSA data. In addition, the simulated GU40(MAX) is less than the simulated average speed, just as in the legacy sensor data. This result strengthens the speculation that the GU10(MAX) and GU40(MAX) algorithms are at least partially responsible for the discrepancy between peak wind statistics from the legacy and RSA sensors. Further comparisons of real data are underway and efforts are being made to obtain the operational computer code that processes the legacy 1-second data.

Contact Dr. Short at 321-853-8105 or short.david@ensco.com, or Mr. Wheeler at 321-853-8205 or wheeler.mark@ensco.com for more information on this work

Table 2. Comparison of average and peak wind speeds in simulated data and that observed by the Legacy and RSA SE sensor at the 300 ft level of WR Tower 300 for the 4-hour interval 1600 – 2000 UTC on 17 January 2005.

Parameter	*Legacy Obs (knots)*	*RSA SE Obs (knots)*	*RSA NW Obs (knots)*	*Simulated (knots)*
Average Speed	12.45	12.92	12.93	12.81
1-minute peak		15.95	15.85	15.77
GU10(MAX)	13.13			13.93
GU40(MAX)	11.37			12.08

Volume Averaged Height Integrated Radar Reflectivity (VAHIRR) Algorithm (Mr. Gillen and Dr. Merceret)

Lightning LCC (LLCC) and Flight Rules are used for all launches and landings, whether government or commercial, using a Government or civilian Range. These rules prevent natural and triggered lightning strikes to space vehicles, which can endanger the vehicle, payload, and general public. The current LLCC for anvil clouds, meant to avoid triggered lightning, have been shown to be overly conservative. They ensure safety, but falsely warn of danger and lead to costly launch delays and scrubs. A new LLCC for anvil clouds, and an associated radar algorithm needed to evaluate that new LLCC, were developed using data collected by the Airborne Field Mill research program managed by KSC which conducted a performance analysis of the Volume Averaged Height Integrated Radar Reflectivity (VAHIRR) algorithm from a safety perspective. The results suggested that this algorithm would assist forecasters in providing a lower rate of missed launch opportunities with no loss of safety compared with current LLCC. The VAHIRR algorithm, needed to evaluate the new LLCC, should be implemented on the Weather Surveillance Radar 88 Doppler (WSR-88D) as it is the only radar available to most current and future users. The AMU will develop the new VAHIRR algorithm for implementation in the WSR-88D system under Option Hours funding. Mr. Gillen and software engineers of ENSCO, Inc. will work closely with key personnel at the Radar Operations Center (ROC) in Norman, OK and NASA to ensure smooth and proper transition of this product into operations.

Work on this task to date has been focused on transferring the algorithm from the National Center for Atmospheric Research facility to the ENSCO facility. Mr. Gillen has also had discussions with Mr. Tim Crum and Mr. Randy George at the ROC on the process of integrating new algorithms into the WSR-88D operational baseline.

Contact Mr. Gillen at 321-783-9735 ext. 210 or gillen.robert@ensco.com, or Dr. Merceret at 321-867-0818 or Francis.J.Merceret@nasa.gov for more information on this work.

MESOSCALE MODELING

Mesoscale Model Phenomenological Verification Evaluation (Ms. Lambert)

Forecasters at SMG, 45 WS, and NWS MLB use model output data on a daily basis to make their operational forecasts. Models such as the Advanced Regional Prediction System (ARPS), the Rapid Update Cycle (RUC), Eta, and Global Forecast System (GFS) aid in forecasting such phenomena as low- and upper-level winds, cloud cover, timing and strength of the sea breeze, and precipitation. Given the importance of these model forecasts to operations, methods are needed to verify model performance. Recent studies have indicated that traditional objective point statistics are insufficient in representing the skill of mesoscale models, and manual subjective analyses are costly and time-consuming. They also concluded that verification of local mesoscale models should be more phenomenologically-based. The AMU was tasked to determine if objective phenomenological verification tools exist in the literature that can be transitioned into operations. Candidate techniques will be identified through a literature search, then the assessing the feasibility of implementing the techniques operationally in the AWIPS at SMG, NWS MLB, and the 45 WS.

Ms. Lambert found over 20 articles that provide descriptions of objective verification techniques at various stages of development. None were developed or were ready for use in operations, and most were concerned with verification of precipitation forecasts.

Ms. Lambert created a table of information summarizing each technique and determining whether the technique was ready for operations. For each technique, the tables show the

- Full reference of the article,
- Weather phenomenon being verified,
- Model being verified,
- Model and observational data used in the verification,
- Time period for the data,
- Name of the technique,
- A brief description of the technique,
- Results from using the technique, and
- Operational readiness of the technique.

For more information on this work, contact Ms. Lambert at lambert.winnie@ensco.com or 321-853-8130.

ARPS Optimization and Training Extension (Mr. Case)

As the ARPS prognostics and ARPS Data Analysis System (ADAS) diagnostics mature for increased operational use, the NWS MLB and SMG require increased accessibility to AMU resources to ensure the most beneficial evolution of these systems. The NWS MLB plans to ingest several new data sets into ADAS, and the operational configuration will be ported to a Linux workstation. In addition, the NWS MLB requires assistance to upgrade the ARPS system to the latest version. The NWS MLB also desires to switch from the RUC 40-km hybrid coordinate fields to the RUC 20-km pressure coordinate fields to use as background fields for ARPS simulations. Finally, a limited examination of several ARPS warm-season convective cases will be necessary to offer suggestions for adaptable parameter modifications leading to improved forecasts of convective initiation and coverage. Therefore, the AMU was tasked to develop routines for incorporating new observational data sets into the operational ADAS and provide the NWS MLB with assistance in making the upgrades and improvements described above.

Mr. Case completed the upgrade and installation assistance of the operational ADAS onto the new Linux workstation at the NWS MLB. He also wrote a Perl script designed to convert intermediate Automated Surface Observing System (ASOS) observations into the format required by ADAS. These ASOS sites can be dialed in directly at 15-minute intervals to supplement the standard METAR report frequency of once per hour except for special observations, resulting in improved ADAS surface analyses at off-hour times.

Mr. Case also configured a real-time version of ARPS in the AMU computer lab to support future work on convective forecast sensitivity tests for this task. To mimic the NWS MLB and SMG configuration, he will need access to the same real-time data sets that are ingested into ADAS at the customer offices. To obtain these data sets, Mr. Case set up the Local Data Manager software on an AMU workstation and coordinated with SMG and ENSCO IT personnel. Real-time data access cannot be established from SMG until after the completion of the upcoming Shuttle mission in July. Meanwhile, Mr. Case will pursue other means of obtaining the necessary real-time data sets in time for the beginning of the Florida convective season.

Mr. Case identified and corrected problems with the ARPS soil and terrain characteristics over the Bahamas. These corrections to the ARPS-fixed fields are particularly important for southeast flow events when upstream convergence zones can develop due to the land-water interfaces of the Bahamas. Figure 13 shows the soil and vegetation type fixed fields using the 1-km resolution database in the ARPS software. Notice that the soil-type field does not represent any of the islands in the Bahamas (Figure 13a), while the vegetation-type field has an accurate representation (Figure 13b). Mr. Case introduced a simple code fix in the ARPS pre-processing program that generates these fixed fields for the model grid. When the vegetation type is not water but the soil type is set to water, the soil is reset to a sandy type. This correction yields an identical depiction of the soil type field over the Bahamas as in the vegetation field of Figure 13b.

Similarly, the 5-minute resolution (~9.25 km) terrain database that was being used in ARPS/ADAS at NWS MLB was much too coarse to resolve many of the islands composing the Bahamas (Figure 14a). Only the two largest islands have any terrain above sea level, and the terrain does not line up well with the geographical map. However, by using the 30-second resolution database (~0.925 km), most of the islands are analyzed accurately by the terrain pre-processor program (Figure 14b). In addition, the terrain over the Florida peninsula lines up better with the coastline. These terrain and soil type corrections/modifications were implemented at the NWS MLB.

Contact Mr. Case at 321-853-8264 or case.jonathan@ensco.com for more information on this work.

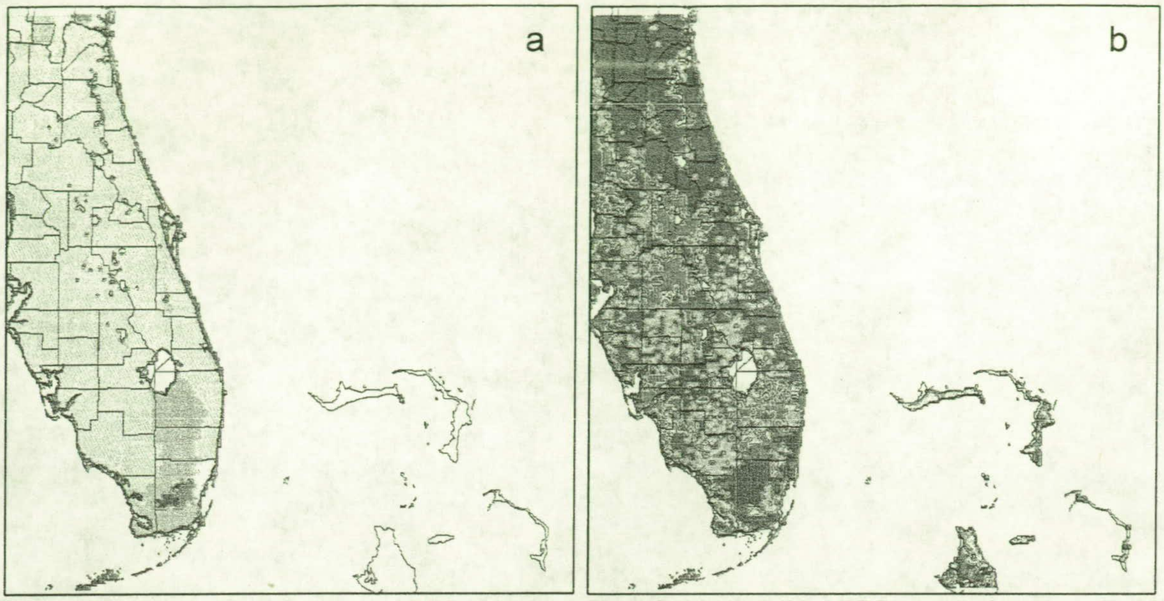


Figure 13. Depiction of the (a) ARPS soil type fixed field, and (b) ARPS vegetation type fixed field prior to the soil-type correction in the ARPS code.

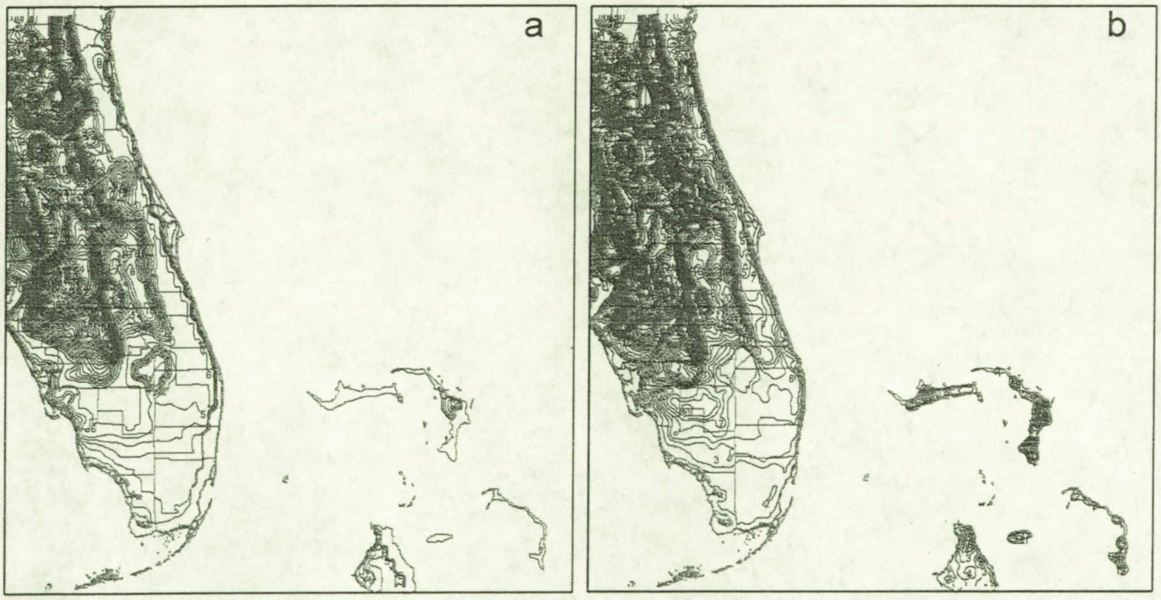


Figure 14. Depiction of the ARPS terrain height in 1-meter contoured intervals for (a) 5-minute terrain data, and (b) 30-second terrain data.

User Control Interface for ADAS Data Ingest (Mr. Keen and Mr. Case)

The integrity of real-time, continuous diagnostic grids from the operational ADAS has become very important, with a requirement to be operationally managed at the forecaster level. Forecasters at NWS MLB and SMG have the need for a user-friendly GUI in order to quickly and easily interact with ADAS to maintain or improve the integrity of each 15-minute analysis cycle. The intent is to offer operational forecasters the means to manage and quality control the observational data streams ingested by ADAS without any prior expertise of ADAS required. Therefore, the AMU was tasked to develop a GUI tool to help forecasters manage the data sets assimilated into ADAS.

Mr. Keen completed the coding and preliminary installation of the ADAS GUI at the NWS MLB office. During the initial installation in late February, he experienced problems with the map background on the Linux platform, which required trouble-shooting. Mr. Keen installed the fully functional control GUI in April. In addition, Mr. Keen and Mr. Case wrote help documentation as part of the control GUI.

Contact Mr. Case at 321-853-8264 or case.jonathan@ensco.com, or Mr. Keen at 321-783-9735 x248, or keen.jeremy@ensco.com for more information on this work.

AMU CHIEF'S TECHNICAL ACTIVITIES (Dr. Merceret)

At the request of the Shuttle Natural Environments Group (SNEG) at Marshall Space Flight Center, Dr. Merceret developed software that generates a database of seasonal 2-hour u- and v-wind component changes in the boundary layer. The selected region from 400 - 3000 m altitude is critical to the Shuttle ascent roll maneuver. Dr. Merceret and Ms. Ward used data from the 915-MHz wind profiler database described by Lambert et al. (2003) to complete the climatology. They also completed 0.25-, 0.5-, and 1-hour climatologies of the vector wind change in the boundary layer. The climatologies provide probability distributions of the vector change as a function of altitude and season for the indicated times over which the change occurred.

After receiving the wind change climatology, the SNEG requested a climatology of the u- and v-wind components themselves. Dr. Merceret and Ms. Ward created and delivered this product.

AMU OPERATIONS

Mr. Wheeler continued working with the KSC procurement office on finalizing the AMU IT purchase requests from 2004. Some of the items still have not been received. He also began to research and request quotes from vendors for some of the 2005 IT items. Requests for the most of the 2005 items were submitted to the KSC NASA procurement office.

Dr. Bauman and Ms. Lambert attended the American Meteorological Society 85th Annual Meeting in San Diego, CA. Ms. Lambert presented the results of the Objective Lightning Forecast task at the Conference on Meteorological Applications of Lightning Data (MALD). Dr. Bauman listened to presentations in the MALD and Interactive Information Processing Systems conferences.

All AMU personnel were involved in writing responses to new task proposals submitted by the 45 WS, SMG, and NWS MLB in preparation for the annual AMU Tasking Meeting on 23 - 24 February. All AMU personnel also attended the meeting. Several new tasks were approved for the coming year. The AMU personnel then wrote task plans for tasks that were approved at the meeting.

REFERENCES

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Wilks, D. S., 1995: *Statistical Methods in the Atmospheric Sciences*. Academic Press, Inc., San Diego, CA, 467 pp.

List of Acronyms

30 SW	30th Space Wing
30 WS	30th Weather Squadron
45 RMS	45th Range Management Squadron
45 OG	45th Operations Group
45 SW	45th Space Wing
45 SW/SE	45th Space Wing/Range Safety
45 WS	45th Weather Squadron
ADAS	ARPS Data Analysis System
AFSPC	Air Force Space Command
AFWA	Air Force Weather Agency
AMU	Applied Meteorology Unit
ARPS	Advanced Regional Prediction System
ASOS	Automated Surface Observing System
AWIPS	Advanced Weather Interactive Processing System
CAPE	Convective Available Potential Energy
CCAFS	Cape Canaveral Air Force Station
CGLSS	Cloud-to-Ground Lightning Surveillance System
CSI	Critical Success Index
CSR	Computer Sciences Raytheon
CT	Cross Totals
EDT	Eastern Daylight Time
ER	Eastern Range
FAR	False Alarm Ratio
FSL	Forecast Systems Laboratory
FSU	Florida State University
FY	Fiscal Year
GFS	Global Forecast System
GUI	Graphical User Interface
HSS	Heidke Skill Score
JSC	Johnson Space Center
KI	K-Index
KSC	Kennedy Space Center
LCC	Launch Commit Criteria
LLCC	Lightning LCC
LI	Lifted Index
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NE	Northeast
NOAA	National Oceanic and Atmospheric Administration
NPTI	Neumann-Pfeffer Thunderstorm Index
NSSL	National Severe Storms Laboratory
NW	Northwest
NWS MLB	National Weather Service in Melbourne, FL
PC	Personal Computer
POD	Probability of Detection
PW	Precipitable Water
QC	Quality Control
RH	800–600 mb Average Relative Humidity
ROC	Radar Operations Center
RSA	Range Standardization and Automation
RUC	Rapid Update Cycle
SE	Southeast
SLF	Shuttle Landing Facility
SMC	Space and Missile Center
SMG	Spaceflight Meteorology Group
SNEG	Shuttle Natural Environments Group
SRH	NWS Southern Region Headquarters
SW	Southwest
SWEAT	Severe WEAther Threat
T_{500}	Temperature at 500 mb
TI	Thompson Index
TPS	Thunderstorm Probability Study
TSS	True Skill Statistic
TT	Total Totals
USAF	United States Air Force
UTC	Universal Coordinated Time
VAHIRR	Volume Averaged Height Integrated Radar Reflectivity
WR	Western Range
WSR-88D	Weather Surveillance Radar 1988 Doppler
WWW	World Wide Web
XMR	CCAFS Sounding 3-letter Identifier

Appendix A

AMU Project Schedule 30 April 2005				
AMU Projects	**Milestones**	**Scheduled Begin Date**	**Scheduled End Date**	**Notes/Status**
Objective Lightning Probability Phase I	Literature review and data collection/QC	Feb 03	Jun 03	Completed
	Statistical formulation and method selection	Jun 03	Oct 03	Completed, but delayed due to errors found in COTS software
	Equation development, tests with verification data and other forecast methods	Aug 03	Nov 03	Completed, but delayed due to errors found in COTS software
	Develop operational products	Nov 03	Jan 04	Completed, but delayed as above and due to hurricane evacuations
	Prepare products, final report for distribution	Jan 04	Mar 04	First draft of final report completed
Severe Weather Forecast Tool	Local and national NWS research, discussions with local weather offices on forecasting techniques	Apr 03	Sep 03	Completed
	Develop database, develop decision aid, fine tune	Oct 03	Apr 04	Completed, but delayed due to higher priority Shuttle Ascent Camera Cloud Obstruction Forecast Task
	Final report	May 04	Jun 04	First draft of final report completed
Stable Low Cloud Evaluation	Gather data, develop database	Oct 04	Jan 05	Completed
	Identify, classify weather characteristics of events	Jan 05	Jul 05	On Schedule
	Gather data, develop database	Aug 05	Oct 05	On Schedule
Hail Index	Evaluate Current Techniques	Aug 04	Feb 05	Completed
	Memorandum	Mar 05	May 05	On Schedule

AMU Project Schedule 30 April 2005				
AMU Projects	Milestones	Scheduled Begin Date	Scheduled End Date	Notes/Status
Shuttle Ascent Camera Cloud Obstruction Forecast	Develop 3-D random cloud model and calculate yes/no viewing conditions from optical sites for a shuttle ascent	Jan 04	Jan 04	Completed
	Analyze optical viewing conditions for representative cloud distributions and develop viewing probability tables	Feb 04	Feb 04	Completed
	Memorandum	Feb 04	Jan 05	Completed
Shuttle Imaging Weather Tool	Develop McBASI source code with documentation for installation and operation	Feb 05	Mar 05	Completed
RSA/Legacy Sensor Comparison	Data Collection and Pre-Processing	Dec 04	May 05	On Schedule
	Data Evaluation	Dec 04	Jun 05	On Schedule
	Final Report	July 05	Sep 05	On Schedule
Volume-Averaged Height Integrated Radar Reflectivity (VAHIRR)	Acquisition and setup of development system and preparation for Technical Advisory Committee (TAC) meeting	Mar 05	Apr 05	On Schedule
	Software Recommendation and Enhancement Committee (SREC) meeting preparation	Apr 05	Jun 05	On Schedule
	VAHIRR algorithm development	May 05	Oct 05	On Schedule
	ORPG documentation updates	Jun 05	Oct 05	On Schedule
	Preparation of products for delivery and memorandum	Oct 05	Jan 06	On Schedule
Mesoscale Model Phenomenological Verification Evaluation	Literature search for studies in which phenomenological or event-based verification methods have been developed	Jun 04	Jan 05	Completed, but delayed due to COTS software issues found in the Objective Lightning task
	Determine operational feasibility of techniques found in the literature	Jul 04	Jan 05	Completed
	Final Report	Jan 05	Mar 05	Delayed as above

AMU Project Schedule 30 April 2005				
AMU Projects	Milestones	Scheduled Begin Date	Scheduled End Date	Notes/Status
ARPS/ADAS Optimization and Training Extension	Provide the NWS Melbourne with assistance in upgrading to ARPS version 5.x.	Aug 04	Dec 04	Completed
	Provide the NWS Melbourne with assistance in porting the operational ADAS to a Linux workstation	Oct 04	Jan 05	Completed
	Assist the NWS Melbourne in upgrading to the 20-km RUC pressure coordinate background fields	Oct 04	Jan 05	Withdrawn
	Develop routines for incorporating new data sets into ADAS	Dec 04	May 05	On Schedule
	Examine a limited number of warm-season convective cases	May 05	Jul 05	On Schedule
User Control Interface for ADAS Data Ingest	Develop control graphical user interface (GUI)	Apr 04	Jan 05	Completed
	Installation assistance and documentation	Jan 05	Mar 05	Completed

NOTICE